

**SWASH PLATE DRIVE SYSTEM**

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**TECHNICAL FIELD**

This invention relates to swash plate drive apparatus.  
The invention is applicable, for example, for use in compressors.  
10 However, the invention can be utilized in and with equipment  
other than compressors.

**BACKGROUND OF THE INVENTION**

The use of swash plates in compressors and other types  
15 of equipment is well known. Swash plates convert rotary motion  
into reciprocating motion imparted to pistons or other members.

In conventional swash plate arrangements, it is  
standard practice to provide structure preventing rotation of the  
swash plate and provide mechanical linkages, such as connector  
20 rods, between the non-rotating swash plate and pistons or other  
reciprocating members actuated thereby. Such arrangements  
produce wear and metal fatigue in the swash plate and associated  
structure.

## DISCLOSURE OF INVENTION

The present invention relates to a unique approach for converting rotary motion into reciprocating motion. The arrangement eliminates the need for an anti-rotation means for the swash plate, allowing different locations on the contact surface of the swash plate to be engaged during operation. This greatly reduces wear and metal fatigue at the contact points. Also, the apparatus of the present invention eliminates the need for a connecting rod or other interconnecting structure between the swash plate and reciprocating members at fixed locations thereon.

The invention relates to a combination of structural elements including a housing defining a housing interior.

A swash plate drive shaft is disposed within the housing interior and rotatably mounted relative to the housing about an axis of rotation.

A swash plate is mounted on the swash plate drive shaft and angularly disposed relative to the axis of rotation, the swash plate being located in the housing interior. The swash plate has an outer swash plate portion surrounding the swash plate drive shaft and generally freely rotatably moveable about and relative to the swash plate drive shaft. The outer swash plate portion has a contact surface.

The apparatus also includes a plurality of spaced reciprocating members mounted for reciprocatable axial movement relative to the housing and engaging the contact surface of the outer swash plate portion. The locations of contact between the contact surface and the reciprocating members changes when the outer swash plate portion rotates about the swash plate drive shaft.

The swash plate comprises a ball bearing assembly, the outer swash plate portion comprising an outer race of the ball bearing assembly.

Other features, advantages and objects of the present invention will become apparent with reference to the following description and accompanying drawings.

#### **BRIEF DESCRIPTION OF DRAWINGS**

Fig. 1 is a perspective view of an air compressor incorporating the present invention;

Fig. 2 is an exploded, perspective view illustrating selected components of the compressor, including a housing, a swash plate drive shaft, a swash plate and one reciprocating member to be actuated by the swash plate;

Figs. 3A and 3B are sectional views taken along the line 3-3 in Fig. 1 and illustrating selected components of the invention in alternative relative positions assumed thereby

during operation of the compressor; and

Fig. 4 is a greatly enlarged, cross-sectional view illustrating an upper portion of the compressor housing, a swash plate drive shaft, a swash plate constructed in accordance with the teachings of the present invention mounted on the swash plate drive shaft and reciprocating members mounted for axial reciprocatable movement relative to the housing and engaged by the swash plate.

#### BEST MODE FOR CARRYING OUT THE INVENTION

Referring now to the drawings, an air compressor incorporating the present invention is illustrated, the compressor having a housing 12 defining a housing interior 14.

A swash plate drive shaft 20 is disposed in the housing interior and rotatably mounted relative to the housing by a motor of the compressor about an axis of rotation A (see Fig. 4). A portion 22 of the drive shaft is canted, i.e. angularly oriented relative to axis of rotation A. Bearings such as ball bearing 24 are disposed about the drive shaft to rotatably support the drive shaft relative to the compressor housing.

A swash plate 30 in the form of a ball bearing assembly is mounted on the swash plate drive shaft and angularly disposed relative to axis of rotation A, the swash plate being located in housing interior 14.

The outer swash plate portion of the ball bearing assembly comprising the swash plate is in the form of an outer ball bearing assembly race 32. The ball bearing assembly further includes an inner race 36 and ball bearings 40 disposed between the inner race and the outer race. The inner race is fixedly secured to drive shaft portion 22 and the outer race 32 is freely rotatably moveable about and relative to the swash plate drive shaft 20.

The outer race or swash plate portion 32 has two substantially planar contact surfaces 42, 44 which are substantially parallel to one another.

The outer race 32 also has a convexly curved outer peripheral wall 50 adjacent to and extending between contact surfaces 42, 44. The convexly curved outer peripheral wall 50 comprises a segment of an imaginary sphere.

The illustrated compressor also includes spaced reciprocating members. Two such members 52, 54 are illustrated. The reciprocating members are in the form of pistons, the topmost portions thereof (as viewed in the drawings) being of different diameters. In swash plate compressors per se, the feature of pistons having different diameters is commonplace and conventional, the pistons slidably positioned for reciprocatable movement in bores of corresponding size formed in the compressor housing. Typically, there are three or more such pistons.

Typically, pistons or other reciprocating members associated with a conventional swash plate are attached to the swash plate by connector rods or other mechanical linkages and the swash plate is fixed against rotatable movement. As will now  
5 be seen, the arrangement of the present invention is substantially different and does not have the drawbacks and disadvantages discussed above found in conventional arrangements.

In the present invention, the reciprocating members have cavities 70, 72 receiving the outer race. These cavities  
10 are respectively defined by concavely curved cavity walls 74, 76 of the reciprocating members or pistons. The concavely curved cavity walls 74, 76 and the convexly curved outer peripheral wall 50 of the outer race conform in shape. The peripheral wall 50 engages the cavity walls 74, 76 during all stages of the  
15 operation of the apparatus. The outer race 32 has a central diametric axis and the axis of rotation A of the swash plate drive shaft is intersected by the central diametric axis of the outer race substantially at the center of the imaginary sphere of which the convexly curved outer peripheral wall of the outer race  
20 comprises a segment.

In the arrangement illustrated, the substantially parallel, substantially planar contact surfaces 42, 44 are engaged by ball bearings 80 of the reciprocating members projecting into cavities 70, 72 and engaging the two

substantially planar contact surfaces.

As is the case with conventional swash plate arrangements, rotation of the swash plate drive shaft will cause the swash plate to wobble, as illustrated, for example, in Figs. 3A, 3B. This movement will be translated into reciprocable axial movement of the pistons relative to the housing.

As compared to prior art arrangements, however, the outer race or outer portion of the ball bearing assembly 30 is free to rotate and in fact does so, continuously placing different locations on the contact surfaces of the swash plate into engagement with ball bearings 80, greatly reducing wear and metal fatigue at the contact points. Furthermore, the unique interconnection between the swash plate and the reciprocating members eliminates the need for a connecting rod between the swash plate and reciprocating members at fixed locations thereon and the associated connector rod bearings.